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OUR BROADCASTING STATION

By J. E. ANDERSON, '27 and E. C. HECK, '29

THE Ohio State University was one of the first schools to install a radio broadcasting station, and the present outfit is the result of much experimentation. One of the earlier sets tried was an experimental 100 watt outfit. Then the power was increased to 500 watts, using Radio Corporation tubes. The next step was a change to Western Electric tubes, which were incorporated in a new set located in the Communication Laboratory. This transmitter served very well, but plans were made for a still better station. The old station was left intact as an auxiliary, and construction of the new station started a year ago last summer. The present radio station, which we know as WEAO, was completed in the fall of 1925.

The antenna is the first thing the visitor notices when he looks over the station. The two masts are 138 feet high, and are spaced 200 feet between centers. These masts are the self-supporting pyramid type. Angle-iron construction is used throughout, and no guy wire bracing is needed. The antenna proper is stretched between these towers, insulated at either end by 24-inch glazed porcelain insulators. This antenna is of the T type. The flat top portion is composed of six No. 8 hard drawn copper wires held on 18-foot spreaders. The vertical lead-in is a six-wire cage, and at the lower end it enters the station through a wall insulator.

The counterpoise is of the radial type. Ten wires with their center at the station are stretched to poles forming a circle around the station. These poles are 18 feet high, and serve to keep the counterpoise well off the ground.

The station also uses a ground to keep the filament of the tubes at ground potential. The ground is a duplicate of the counterpoise in size and shape. Ten buried wires radiate from the station, each under a counterpoise wire.

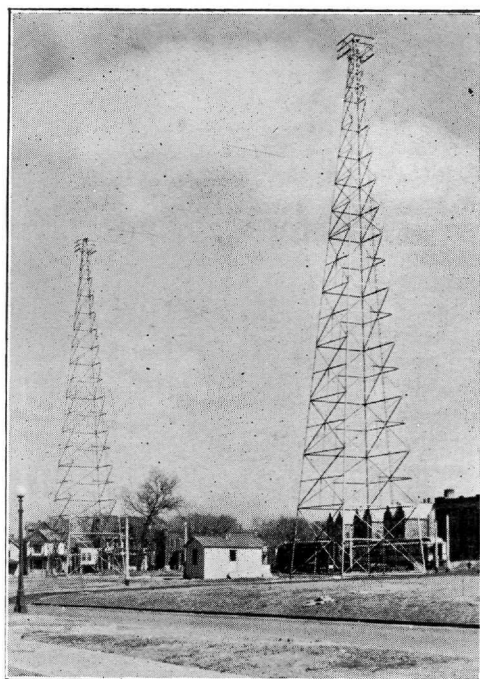
The Transmitting Station

The transmitting instruments are located in a small building between the masts, so that a direct vertical lead to the antenna may be secured. There are two rooms in this building; one contains the transmitter proper and control

desk; the other houses the motor-generator sets. The control desk is on the west side of the first room, and the transmitting panels are mounted along the north side so that all instruments are in clear view of the operator.

The transmitting outfit is mounted on the left hand panel, and on three shelves built up behind it. On the top shelf is mounted the antenna tuning circuit, and the closed oscillating circuit apparatus. The middle shelf contains six Western Electric 212D 250 watt tubes. Three are used as oscillators, and three as modulators. The bottom shelf is used to mount a filter system, a constant current choke for the modulator, an oil circuit breaker in the high voltage lead, and a one-stage, 50-watt power amplifier using a W. E. 211D 50-watt tube.

The circuit is a Hartley oscillator using Heising modulation. A system of capacity coupling is used between closed and open oscillating circuits. Referring to the circuit diagram of the apparatus LI is the antenna inductance. This inductance in combination with the series condensed C_1 is used to tune the antenna to the desired wave length. The closed circuit inductance L_2 and condenser C_3 tune the closed circuit. The coupling condenser, indicated by C_2 ,



Towers for the Antenna

is used to transfer the energy from the closed to the open oscillating circuit. The condenser C_4 is the plate blocking condenser. The grid condenser and leak are shown as C_5 and R_1 . The radio frequency choke L_3 , in the oscillator plate circuit common lead, is provided to keep the high frequency current from the modulator circuit. The iron core choke L_4 is the constant current or modulation choke necessary in the Heising system of modulation. The chokes L_5 and L_6 are small radio frequency chokes used to prevent ultra high frequency oscillations between tubes. The by-pass across the filament circuit is indicated by C_6 . The resistance R_2 is provided to equalize the grid voltage throughout the filament. The speech amplifier plate voltage is reduced to the correct value by R_3 . The filament voltage is reduced in the same way by R_5 . The speech amplifier tube is shown as S. A. The resistance R_4 is provided in the negative plate supply lead to give a voltage for a grid bias. The filter, Fil., suppresses generator

commutator ripples. The circuit breaker, denoted by C. B., is used as a safety factor in case the plate load should rise to an unsafe value. The transformers T and T are the modulator input, and speech amplifier input transformers respectively. The various meters are indicated as V for voltmeters and A for amperes and milli-amperes.

Power Supply and Motor-Generators

The power is supplied to the station through a 440-volt single-phase system. Buried lead-covered cables are used for all power supply lines. The power is tapped from the Communication Laboratory circuits, or from the Robinson Laboratory circuits as an auxiliary source.

At the station the 440 volt line is connected to a transformer which delivers 220 volts for driving the motor-generators, and 110 volts for lighting.

The three motor-generators are located in the east room of the station. The main motor-generator is composed of a 5 H.P. motor which drives two 1000-volt 1 K.W. direct current generators. These generators are connected in series to supply the plate circuit power. Thus a power of 2 K.W. at 2000 volts is available for the plate. These two generators are separately excited by another 1 K.W. motor-generator which delivers 125 volts D.C. This generator is also used to charge the storage B battery for the power amplifier. The third motor-generator is used to supply the filaments of the tubes. It delivers 56 amperes at 14 volts.

Station Control

The station is operated from the desk on the west side of the room. All microphone and control circuits are brought to this desk, and a receiving set, volume indicator, and three-stage power amplifier are mounted on the panel of the desk.

At the left side of the desk is the microphone line and order switch board. It is a thirty-drop

board with two jacks for each drop. This switch board connects to a 26-pair cable containing microphone and order telephone lines leading to various buildings on the campus, and to other points from which it may be necessary to broadcast. Another six-pair cable, which contains order and microphone warning light circuits, also terminates here.

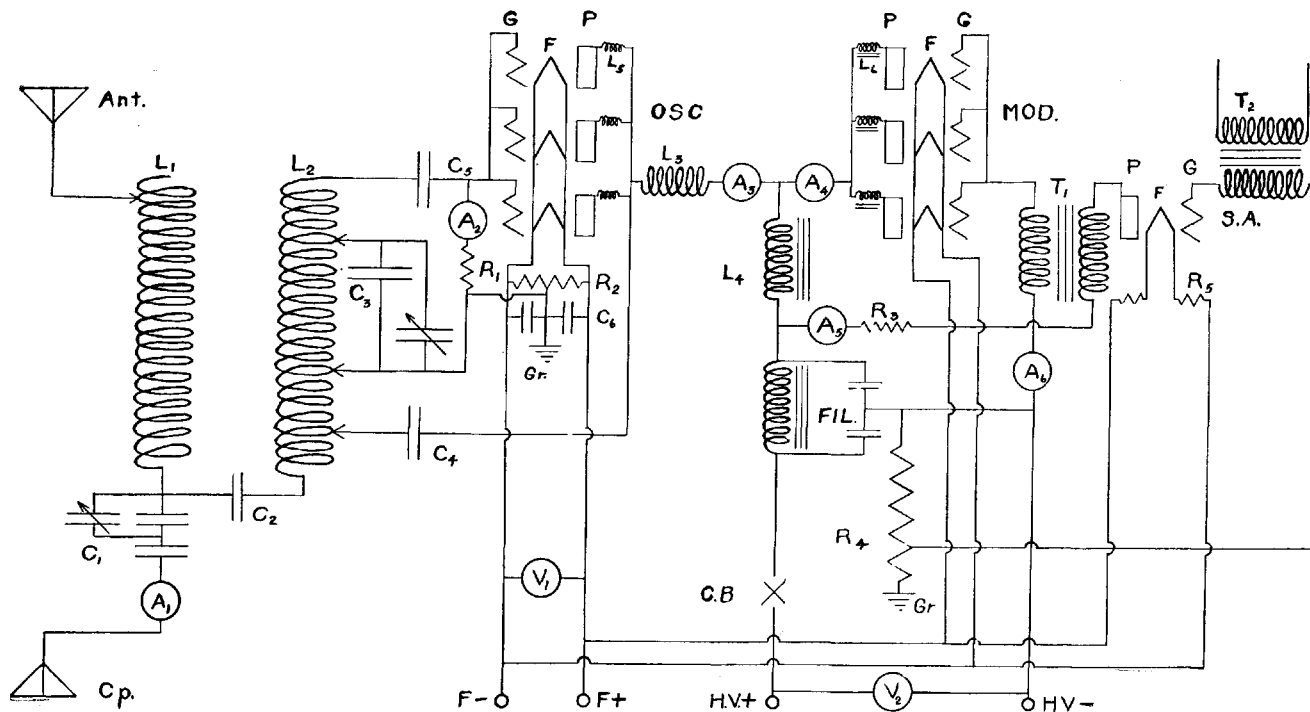
The monitor receiving set is an ordinary two-stage amplifier non-regenerative outfit. It is tuned to receive the transmitted wave of the station, and operates a loud speaker so that the operator can have a constant check on the quality of modulation of the transmitter.

The power amplifier for the microphone circuit is also located on the control desk. The amplifier is a three-stage impedance coupled type, which was carefully constructed to eliminate distortion, and shielded to prevent high frequency pick-up from the intense field of the transmitter. The first two stages are voltage amplifiers using Western Electric 102D tubes. The amplification constant is about 30. These two tubes operate at 150 volts plate potential. The third stage is a power amplifier using a 205D tube with 350 volts on the plate. All speech or music going into the transmitter passes through this amplifier.

Due to the varying volume of the sounds entering the microphone at the studio, a method of volume control must be employed at the transmitter to avoid over modulation and distortion.

The magnitude of the speech voltage is indicated in two ways. The plate circuit ammeter on the main transmitting panel is in plain view of the operator and serves as an indication of the speech voltage impressed on the transmitter. Then there is a separate volume indicator on the control panel. It consists of a vacuum tube biased so that practically a zero plate current flows. The speech voltage impressed

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Schematic Circuit Diagram of WEAQ Transmitter



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on the grid allows a current to flow in the plate circuit which is proportionate to the impressed speech voltage. This plate current is indicated on a galvanometer. Whenever these two indicating devices approach values that are likely to cause distortion, the speech voltage must be reduced. Formerly the operator watching these meters reduced the speech voltage when he judged it to be excessive. The latest development at WEAO is a third ammeter in the grid circuit of the main oscillating tube which normally stands at zero; whenever the speech voltage becomes too high this meter shows a reading, and the impressed speech voltage must be reduced.

The control of the speech voltage, or the volume control, consists of a variable shunt resistance in the form of a potentiometer connected from grid to filament in the second step of the speech amplifier. By decreasing the resistance of the shunt, less speech-voltage is impressed on the transmitter tubes.

Studios and Points of Broadcasting

Through the previously mentioned switch board on the control desk, the station can broadcast from a number of sources. Thirteen buildings on the campus are permanently connected to lines running to the station. The main studio is located in the Communication Laboratory and its microphone and control circuits run directly to the station. A studio is maintained down town at the Neil House. There are also permanent lines running to the Stadium and to the Coliseum.

The studio proper is next to the waiting room. Here are the microphones that pick up the speech or music to be broadcast. The microphones are mounted on adjustable stands to secure the best pick-up. They are of Western Electric make, incorporating double buttons mounted on a stretched steel diaphragm.

The announcer's desk is located in the studio. It mounts the announcing microphone, the microphone selection switches, and the signal lights from the station.

The control box on the announcing desk has a green light which, when lighted, signals the announcer that the transmitter is in operation at the station, and that the microphone may be turned on. The announcer may switch in his microphone or any of the other microphones in the studio. When any of these microphones are switched on a red light signals the operator at the station that the microphone is on, and a red light mounted in the studio warns the performer that he is ready to broadcast. Lights on the announcer's control box indicate which microphone is connected.

In broadcasting from the Stadium or other points where a regular studio is not provided it is necessary to take a portable power amplifier, microphone, and order telephone. With these arrangements it is possible to broadcast from any of the buildings on the campus within a few hours' notice.

For control inter-communication there is a complete magneto telephone system, so that, when it is necessary to broadcast from any of

the outlying buildings, efficient telephone communication for control is secured.

The radio station was designed and built at The Ohio State University under the direction of R. C. Higgy, who is acting director of broadcasting.
